

Mr. Netten Radcliffe's Report to the Local Government Board on the Sanitary Condition of Gravesend, Kent.

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September 24, 1877.

The following Report relates to an inquiry, carried out under instructions from the Local Government Board, as to a series of complaints made to the Board by several persons resident in Gravesend with reference to the prevalence of dangerous infectious disease in the town, to certain alleged defects in its sanitary arrangements and administration, and to the existence of sundry specified nuisances. The attention of the Board was particularly called to:—

- (1.) The prevalence of scarlet fever of a malignant type, and of enteric fever, and the absence of any means of isolating cases of infectious disease;
- (2.) The want of sewerage, the common use of cesspools, and the unwholesome conditions thence arising;
- (3.) A great nuisance at the canal basin east of the town, caused by the deposit there and by the carting away of highly offensive stuff, including decaying fish, used as manure;
- (4.) A nuisance from the discharge of sewage on the bed of the river, above low-water mark, at the foot of the town pier; and
- (5.) A nuisance from a deposit of vegetable matter, manure, and rubbish on Windmill Hill.

Each of these complaints has been subjected to investigation, the result of which I now proceed to report.

GRAVESEND, situated on the right bank of the Thames, 20 miles below the metropolis, and the place of entrance to and departure from the port of London, is a municipal borough and registration district. It includes two parishes, namely, Gravesend and Milton-by-Gravesend, and has an area of 1,256 statute acres. In 1871 the population of the borough was 21,265, and the number of inhabited houses 3,485.

The town of Gravesend, in which almost the whole of the population and houses of the borough are collected, occupies the slopes and summit of a hill which rises from the border of the Thames to an altitude of 175 feet above Ordnance datum. On the north the town extends along the bank of the river and is bounded by the stream; on the south it is bounded by the open country; on the east by the marshes which fringe the right bank of the river in that direction and by the cultivated rising ground above them; and on the west it is separated by meadow and garden land, with the exception of certain lines of buildings on the main connecting thoroughfares, from the urban sanitary district of Northfleet, including Northfleet and the village of Perry Street. With the exception of the portion of the town immediately on the banks of the river and about the principal street, the High Street, where the buildings are huddled together about narrow thoroughfares, passages, and courts (some of the latter closed) after the fashion of old seaport towns, the houses have more or less open space in rear and are for the most part built along streets, which are usually broad and open, relatively to the height of the buildings on each side, and which cross each other commonly at right angles. There are few localities of the town, indeed, that are not freely swept by every movement of the air.

The greater part of the town lies upon chalk, here horizontally bedded, and, except the uppermost stratum, apparently not much fractured or fissured. But the higher portion

of the town is built upon a bed of sand, gravel, loam, laminated clay, and other clays (an outlier of the lower tertiary formation of the London basin, belonging to the Thanet and Woolwich series, which here caps the chalk); and a small section on the bank of the river and in the low-lying ground rests on alluvium. With the exception it may be (the question being as yet undetermined) of a few houses situated on the edge of the trough which apparently holds on the higher ground the cap of sand, gravel, and clays just described, and the houses in the lowest part of the town, of which the foundations must rest near to the water-line of the chalk, the site of Gravesend, from the porosity of the soil on which it stands and from the facility with which the rainfall flows off, is very dry.*

Gravesend, in fact, apart from its proximity to the marshes on the east, occupies a site which offers peculiar facilities for securing the wholesomeness of the town. Moreover, in all except the oldest portions—namely, on the river side and about the High Street—the arrangement of the streets and houses in respect to openness is such as, other things being equal, to give effect to the favourableness of its position and site.

But notwithstanding this advantageousness of situation, Gravesend, as gauged by its mortality, has not been a healthy town.†

During the decade 1851–60 the general mortality of Gravesend marched near upon that of the metropolis (226 per 10,000 population as compared with 236), and its mortality from “fever” (8·8 as compared with 8·5) was equal to and from *diarrhœal disease* (21·3 as compared with 15·2) was actually in excess of that of the metropolis. Gravesend, indeed, during this period, had a higher mortality from “fever” than such districts of the metropolis as Clerkenwell (5·9), St. Luke (7·3), Poplar (6·9), Bermondsey (7·8), Lambeth (7·1), &c., and from *diarrhœal disease* than all the districts of the metropolis, four only excepted (St. Saviour’s; St. Olave’s; St. George’s, Southwark; and Rotherhithe).

During the next decade, 1861–70, there was in Gravesend a diminution of the general mortality, and of the mortality from the two classes of disease which have been specified.

* My colleague, Dr. Buchanan, in his investigation concerning the distribution of phthisis as affected by dampness of soil, made in 1867, estimated that out of the then population of Gravesend (which came within the area of country submitted to examination) 50 lived on alluvium, 4,000 on the lower tertiaries (the sand, gravel, and clays, referred to in the text), 13,989 on chalk, and 743 on board vessels. The relative proportions of the population living on the different soils will have changed very little, if at all, I infer, since this estimate was made.

† TABLE showing the Mean Annual Death Rate, per 10,000 living at all Ages, in GRAVESEND, from certain specified Diseases, in the Decades 1851–60, 1861–70, the Five Years 1871–75, and in 1876.

Population at all Ages.		District and Period.		Mean Annual Death Rate per 10,000 living at all Ages.				
				All Causes.	Fever ("Typhus" of the Registrar-General).	Diarrhœa, Dysentery, and Cholera.		Scarlet Fever.
						Inclusive of Epidemic Cholera.	Exclusive of Epidemic Cholera, 1854, 1866.	
Mean population	- { 17,707 2,583,112 91,830	1851-60.						
		Gravesend	- -	226·5	8·8	21·3	16·3	8·2
		London	- -	236·3	8·5	15·2	11·0	9·4
		Standard Group of Rural Districts.		166·0	6·0	5·7	5·7 ?	4·6
Mean population	- { 20,023 3,029,125 110,922	1861-70.						
		Gravesend	- -	219·1	7·8	13·6	12·4	10·2
		London	- -	243·1	8·9	12·9	11·0	11·4
		Standard Group of Rural Districts.		165·0	4·8	5·7	5·7 ?	5·5
Estimated mean population.	{ 21,797 3,353,498	1871-75.						
		Gravesend	- -	194·9	4·1	7·7	7·7	3·6
		London	- -	230·4	4·4	11·1	11·1	5·8
Estimated population	{ 22,618 3,489,428	1876.						
		Gravesend	- -	177·2	3·0	13·2	13·2	12·8
		London	- -	221·8	3·3	10·6	10·6	6·6

There was now no longer any near approximation between the general mortality of Gravesend and of that of the metropolis, and this came about partly from the decrease of the mortality in the former place, and partly from an increase in the latter place. The mortality from "fever," moreover, fell during this decade below that of the metropolis (7·8 as compared with 8·9), but the mortality from diarrhœal disease still continued above the metropolitan rate (13·6 as compared with 12·9).

During the five years following the last decade (1871-75) there would appear to have been a still further decline of the general mortality in Gravesend, and of the mortality from "fever," and from diarrhœal disease, the mean annual rate of the general mortality having sunk to 194, of "fever" to 4·1, and of diarrhœal disease to 7·7.

The diarrhœal death-rate in the two decades 1851-60 and 1861-70 was swollen by the epidemics of cholera of 1854 and 1866. Excluding the deaths from cholera which occurred in these years it would appear that the diarrhœal death-rate of the metropolis has remained stationary during the 25 years (1851-75) of which the data have been submitted to examination, while that of Gravesend has progressively decreased. The decrease, indeed, in 1871-5 was to the extent of 50 per cent. of the original rate in 1851-60; but a certain fresh increase has been observed in 1876. The data at my command are insufficient to admit of a clear judgment being formed of the nature and probable source of this declension of the diarrhœal death-rate of the borough, but they would indicate that the earlier decrease of mortality was chiefly among adults and not among infants.*

The conditions which have probably most contributed to bring about the continuous improvement in the sanitary state of Gravesend, indicated by the steadily diminishing mortality, and especially by the diminished mortality from "fever" and from diarrhœal disease, will be in part shown in this Report. The Report will also show how much there is still to be accomplished in Gravesend before its present improved sanitary state can be accepted as representing the health-standard of the borough, and before the health-capacity of the place is fully developed.

Infectious Diseases.—The recent prevalence of scarlet fever and of enteric fever in Gravesend, to which inquiry was first directed, furnishes a striking illustration of the extent to which the borough is still liable to suffer from infectious diseases.

There has been no quarter since the last quarter of 1873 in which a death from *scarlet-fever* has not been registered in the borough, and in several of the quarters of this period two or more deaths have been registered. In the third quarter of 1874 the number of deaths registered from this disease was seven, and in the fourth quarter not less than 15. During the last quarter of 1876, following upon epidemic prevalence of the disease in several localities east of Gravesend and in the metropolis, scarlet fever became very active and fatal in the borough, and in that and the two subsequent quarters it spread epidemically throughout it. The number of deaths registered from the disease in the last quarter of 1876 (22), and the first (37), and second (15) quarters of the present

* GRAVESEND:—Deaths from Dysentery, Diarrhœa, and Cholera.

Ages.	1851-60.			1861-70.		
	Mean Population.	Total Deaths from these Causes in the Decade.	Annual Rate of Mortality per 10,000 living at each Age Period.	Mean Population.	Total Deaths from these Causes in the Decade.	Annual Rate of Mortality per 10,000 living at each Age Period.
Years.						
Under 5 -	2,326	183	78·6	2,566	187	72·8
5-10 -	2,141	5	2·3	2,422	3	1·2
10-15 -	1,807	3	1·7	2,149	2	·9
15-20 -	1,731	8	4·6	1,976	1	·5
20-25 -	1,593	18	11·2	1,783	4	2·2
25-35 -	2,736	55	20·1	2,919	13	4·4
35-45 -	2,092	40	19·0	2,288	12	5·2
45-55 -	1,489	17	11·4	1,729	9	5·2
55-65 -	1,031	16	15·5	1,195	10	8·3
65-75 -	554	19	34·2	699	8	11·5
75-85 -	188	10	53·1	256	15	58·5
85 and upwards -	29	5	172·0	41	7	171·0

year (1877) have been no less than 74.* I have endeavoured to obtain some account of the actual number of cases of scarlet fever which have occurred in this formidable outbreak, and from returns with which various medical gentlemen practising in Gravesend have courteously forwarded me, I learn that the number under their treatment from the 1st January 1876 to the end of June 1877 has been 369, by far the greater proportion occurring in the last quarter of 1876 and first and second quarters of 1877.

Gravesend has no public means of dealing effectually with the first beginning of an infectious disease, such as scarlet-fever, nor of limiting with any certainty its after-spread. Whether the recent great prevalence of the disease was determined by development of the malady beyond the proportions in which it commonly exists in the borough, or by its importation anew from neighbouring localities where it had previously become actively diffusive, cannot be said. Gravesend had at the time of the outbreak the infection within itself, while at the same time it was freely exposed to infection from without. The essential fact to be had in mind with respect to the dissemination of this disease is that this is effected by the communication of infection from the sick to the well, either directly or through the agency of clothing or other matters which may have been exposed to the infection. Overcrowding and even certain other insanitary conditions of a sort to be presently described, may facilitate the spread of the infection, but fewer infectious diseases are less dependent than scarlet fever on incidental aids of this kind for promoting their diffusion. There are but two means which afford any certain security against the spread of the disease, namely prompt isolation of the sick, and the effectual disinfection of articles which having been exposed to infection may harbour the infection.

Now Gravesend has no means of isolating infectious sick, not even such sick as would come under the operation of section 124 of the Public Health Act, 1875. Hence during the whole of the recent prevalence of scarlet fever it has not been practicable for the Local Authority to isolate a single individual where such isolation was necessary for the safety of the community and could not be had within the patient's home. Hospital provision used for the isolation of early cases of infectious diseases, it must be remembered, is the provision of all others most likely to prevent an epidemic, and this equally whether the early cases of the epidemic were indigenous or imported. Evidence has been submitted to me which has led me to the conclusion that had there been hospital accommodation for the infectious sick in Gravesend it might have been possible either to arrest wholly the progress of the outbreak at the beginning, or if this could not have been achieved, at least to prevent fully one third, if not one half, of the sickness, and probably also, to the same extent, loss of life from the disease. Not only has Gravesend no hospital, but it has also no public means of disinfecting clothing and bedding by heat—the only mode of disinfection which meets properly the exigencies as to disinfection of infectious diseases such as scarlet-fever or small-pox. The Local Authority makes use, it is true, of chemical disinfectants, and it has the excellent plan of destroying by fire, and paying the cost of, beds and bedding which may have been exposed to infection, when its Medical Officer of Health recommends. But such destruction can only meet to a very limited extent the necessity of the case, unless it be made to include all materials (bed-linen, clothing, curtains, &c.) which are liable to receive infection, when the expensiveness of the procedure could hardly be justified, other less costly means being available. Then Gravesend has no mortuary, and the dead from infectious disease are apt to become dangerous sources of infection while the corpse remains unburied within an inhabited house.†

The number of cases of *enteric fever* returned to me as having occurred in Gravesend during recent months (the fever being habitually present) was no less than 106. Almost the whole of these cases occurred during the 11 months following July 1876. The Medical Officer of Health, Dr. Gramshaw, has expressed a doubt whether a few cases of comparatively slight febrile disturbance, but of several days' duration, included

* GRAVESEND :—Deaths from Scarlet-fever.

1871. 1st quarter	-	-	5	1873. 2nd quarter	-	-	—	1875. 3rd quarter	-	-	2
2nd quarter	-	-	—	3rd quarter	-	-	—	4th quarter	-	-	3
3rd quarter	-	-	—	4th quarter	-	-	1	1876. 1st quarter	-	-	4
4th quarter	-	-	3	1874. 1st quarter	-	-	1	2nd quarter	-	-	1
1872. 1st quarter	-	-	—	2nd quarter	-	-	2	3rd quarter	-	-	2
2nd quarter	-	-	—	3rd quarter	-	-	7	4th quarter	-	-	22
3rd quarter	-	-	—	4th quarter	-	-	15				
4th quarter	-	-	1	1875. 1st quarter	-	-	2	1877. 1st quarter	-	-	37
1873. 1st quarter	-	-	—	2nd quarter	-	-	2	2nd quarter	-	-	15

† Twice in the course of this inquiry has small-pox been introduced into Gravesend, and the grave risk of its extension from want of means of isolation incurred. The second case died, and here hardly less risk was incurred from the corpse.

in the foregoing number, should be regarded as instances of enteric fever. The experience of this Department has been that cases of slight febrile disturbance of some days' continuation taking place concurrently with the prevalence of well-marked examples of enteric fever are part of the phenomena of the outbreak, and originate in the same conditions—that, in fact, they are cases of enteric fever. Enteric fever, indeed, is endemic in Gravesend, and is the fatal “fever” of the Registrar-General's returns for that Borough.* Few facts have been more certainly determined in medicine than the dependence of local prevalences of enteric fever upon excremental pollution of the soil, the air, or the water, either singly or in conjunction. To what extent this sort of pollution exists in Gravesend forms the second part of this inquiry with reference to the complaints made to the Board.

Sewerage, Drainage, and the Disposal of Filth.—Gravesend is not sewered. It possesses a few drains, confined almost wholly to the lower part of the town, and designed to carry off surface water. These drains are as a rule old, and in the course of time, house and other connexions have been made with them, and they now receive, in addition to surface water, an undetermined quantity of house drainage, including the contents of waterclosets, of the drainage of slaughter-houses, of stable-yards, &c. They are constructed of brick, and have a quadrangular form, measuring within 2 feet by 2 feet, the invert being slightly concave. Drains of this kind exist in Queen Street, High Street, Stone Street, the New Road, Somerset Street, Bath Street, Princess Street, Church Street, and West Street. Several communications exist between the different drains, and they open at four points on the river front. A small detached drain exists at the western extremity of West Street, and another at the east end of the Terrace, by the Custom House, both also opening upon the river front. A drain also runs from about the middle of Milton Road and opens into the canal basin.

In the higher parts of the town no underground drains have been constructed, and the surface drainage, where it does not find its way to the drains in the lower parts of the town, or reach the river or the land-drains of the open country over the surface, is conducted to dumb-wells excavated for the purpose. These wells, having a diameter of 8 feet at the top and 10 feet at the bottom, are sunk to the water-line in the chalk, which is reached in the localities where they are found at depths varying from 35 feet to 70 feet. In the greater number of these wells, “headings,” measuring 8 feet in length, 2 feet in breadth, and 6 feet in height, are also driven from the bottom into the chalk.

The common mode of disposal of house-drainage and excremental filth in Gravesend is into cesspools. These are of various depths, from a few feet to sixty feet. The shallower cesspools require to be emptied every two or three years, the deeper cesspools at much longer intervals, if at all. As regards, first, the deep cesspools there is little obvious nuisance from those which open to the outer air and are used by one family. Of nuisance from such cesspools when communicating with the interior of dwelling-houses I am unable to speak from experience. But the practice with such cesspools is to close them with a virtually impervious roof and to carry into them the trapped communications of the waterclosets, the sinks, and the yard gulleys; and it is contrary to experience that a water-trap will furnish a sufficient safe-guard to the intrusion of cesspool air into the interior of dwellings under such conditions.

I saw one of these cesspools attached to a private house, and communicating with a detached closet in the outer air. It had probably been in use for over thirty years, and had not been emptied during the whole of that period. The deposit was too deep in the cesspool for me to determine readily its level, but there was a complete absence of perceptible nuisance. On the other hand, I saw deep cesspools which received large quantities of house slops in addition to the excremental filth (which was the case in the first-named), and from which there had been, I was informed, considerable nuisance in the interior of the dwellings to which they were attached. I also saw deep cesspools from which nuisance had arisen by reason of their being flooded by heavy rainfall, and where it had been requisite to excavate additional cesspools to provide against a repetition of the emergency. In the workhouse premises it has been found necessary to multiply these deep cesspools, so that now 18 or thereabout exist there.

The shallow cesspools are without exception abominable nuisances. Hollowed in the uppermost and most porous and fissured stratum of the soil their semi-liquid contents

* GRAVESEND :—Deaths from “Fever.”

1871. 1st quarter - - 1	1873. 2nd quarter - - 2	1875. 2nd quarter - - 1
2nd quarter - - 4	3rd quarter - - 0	3rd quarter - - 3
3rd quarter - - 1	4th quarter - - 1	4th quarter - - 2
4th quarter - - 1	1874. 1st quarter - - 1	1876. 1st quarter - - 1
1872. 1st quarter - - 2	2nd quarter - - 1	2nd quarter - - 1
2nd quarter - - 4	3rd quarter - - 1	3rd quarter - - 2
3rd quarter - - 3	4th quarter - - 9	4th quarter - - 3
4th quarter - - 8	1875. 1st quarter - - 3	1877. 1st quarter - - 3
1873. 1st quarter - - 0		

soak freely into it, polluting the water there, while at the same time they load the air with their offensive effluvium. The cleansing of these cesspools, in any proper sense of the term, is an impossibility. When they become full the gross contents are removed after a fashion, which is not the least objectionable part of the local administration with regard to them. The responsibility for such removal is thrown upon the owner of the house, the removal is undertaken not by the sanitary authority, but by persons who make a business of it, it is carried out at a cost which is prohibitive except under necessity,* and no supervision whatever is exercised by the Local Authority as to the mode of execution.

The Local Authority itself collects and disposes of the comparatively harmless dry house-refuse (ashes, &c.) of the borough, but gives no further heed to the accumulation of excremental refuse than is necessary to prevent nuisance from overflowing receptacles.

As examples of the sort of arrangement which obtains with the shallower cesspools, I may note (a.) *Back Garrick Street*, where a cesspool of five years' capacity, used by the families occupying ten houses, is situated immediately in front of a row of houses and 27 feet from† the draw-well from which the families obtain their drinking water. Four of the cases of enteric fever in the recent prevalence occurred in one of the houses facing the cesspool and its superposed privies. (b.) *Barrack Row* (a row of wood-built through-and-through cottages). Here the privies are placed only *six feet* from the back wall of the cottages. The cesspool needing to be emptied about every two years was nearly full at the time of inspection. The contents of this cesspool, in the process of emptying, have to be carried through one of the cottages, and the emptying, in fact, only takes place when a cottage happens to be empty. The stercoraceous odour pervading the vicinity of this cesspool was sickening. In one of the cottages of Barrack Row five cases of enteric fever (one fatal) occurred during the recent prevalence of the disease. (c.) *Mansfield Place*, a group of about 35 wooden double cottages is curiously honey-combed in the interval of the buildings with cesspools. The inhabitants here very literally live amidst their own excrements. Eight cesspools have been recently excavated to a depth of 60 feet in this property to obviate the nuisance from the shallower cesspools. (a.) *Mann's Buildings*.—Here the privies and cesspool are close to the front walls of the houses. The contents of the cesspool had lately broken through into the lower story of the nearest cottage, which was unoccupied in consequence, at the time of inspection. (d.) *Theatre Buildings*, two rows of four cottages each, and each with an offensive cesspool at the end, which has not been emptied for upwards of two years. Complaint was made by the tenants of one of the rows of the offensiveness of the cesspool attached to it, and of their inability to get the contents removed as it was "not quite full." Water here obtained from a draw-well contiguous to the houses. (e.) *Garden Row*.—The cesspools attached to this row are arranged in couples with the wells from which the occupants draw their water. In the instance taken for measurement the mouth of the well was 10 feet 6 inches from the mouth of the cesspool, the depth of the well to the water level being probably about 60 feet, of the cesspool to the level of the excrement about 20 feet. (e.) *Queen's Terrace, Queen Street*.—A row of 9 three-story cottages in a closed court, rapidly falling into ruinous disrepair, three only occupied. Privies, in rear (insufficient in number if all the cottages were occupied), and very foul and neglected. Cottages occupied by a class of people whose filthy habits can only be counteracted by the Local Authority itself undertaking the removal of filth and cleansing of the surface.‡ (f.) *Terrace Court*.—Five through-and-through houses, with yard in rear. In this yard, which measures 25 feet by 22 feet, are a cesspool and draw-well, the cesspool receiving the contents of five privies, the house slops, and the surface drainage of the yard. The water of the well had been recently analysed by the Medical Officer of Health and found impure, and an order had been served upon the owner of the property to close the well and obtain a supply for the cottages from the water company. (g.) *Brunswick Retreat, Milton*.—Semi-detached cottages with the following arrangement of cesspools and draw-wells in rear. Each cottage has its separate privy and cesspool, but one draw-well serves for two cottages. The well is so situated that its mouth is 10ft. 6in. distant from the mouth of each cesspool of the two cottages to which it belongs.

Water Supply.—Gravesend derives its water supply wholly from the chalk-rock beneath the town. The water is obtained in two fashions, namely, from private wells, and from the works of a water company. The private wells are sunk in close proximity to the cesspools throughout the town. Of this arrangement some examples have been already given. These wells differ from the cesspools in construction in this, that they are sunk to and somewhat within the water level of the chalk, while the cesspools stop short of this, the better to facilitate the absorption of their liquid contents. The water of the shallow wells in the lower parts of the town, particularly those affected by the tide, must necessarily be largely an imperfect filtrate from cesspools, and it must be a mere accident if the water, even in the deep wells of this class—wells of from 60 to 80 feet in depth—escape pollution from this source.

The works of the Water Company,§ which was established in 1834, are situated on the summit of the highest ground in the town, in the outskirts. The Company's supply is obtained from two wells sunk to a depth of about 200 feet, and connected near the

* The charges for emptying cesspools in Gravesend are as follows: 5s. per man per night (three men being commonly engaged); in addition 10s. per waggon-load of filth removed = 3 tons; also 5s. allowance per night to the men for candles and beer. The rule is to remove one waggon-load of filth per night. If two waggon-loads be removed the same night *all* the charges are doubled. The cleansing of an ordinary cesspool, as a rule, occupies three nights.

† The measurements given here are the approximate measurements made by the Inspector of Nuisances and Surveyor at the time of inspection.

‡ The houses in Queen's Terrace have since been put in repair.

§ I am indebted to the courtesy of the Chairman of the Water Company, T. Troughton, Esq., for the particulars given in the text relating to the Company's works and supply.

bottom by a "heading."* When the pumps are not in action the water stands in the wells to a depth of 28 feet. The water is first pumped into an open reservoir, and then distributed (without filtration) by gravitation. The average daily quantity supplied to the borough, *for houses only*, at the present time is 152,738 gallons; the total number of houses supplied is 3,065, of which 2,739 have a separate house-service. According to an estimate of the Company there are still about 762 houses in the borough supplied with water from private wells. The mode of service of the water is thus described: "The water is turned on for seven months 10 hours per day (except Sundays), " and for the remaining five months eight hours. Each district has the water from " one hour to 1½ hour each day; on Saturdays and Mondays twice during the day, " morning and afternoon; an early supply on Monday morning, and a late supply on " Saturday afternoon."

Although no complaint was made to me or came to my knowledge during the inspection of deficiency of supply from the Company, yet several facts came under observation which at least suggested scantiness, and the desirability of a special investigation of this subject being made by the Local Authority. Thus, in the groups of houses supplied by common taps, the means of storage during the intervals of supply possessed by the cottages seemed to me very insufficient, and of a character at times liable to lead to pollution of the water. In these cases some better means of storage seemed to me to be needed, means that might properly answer for two or more cottages. Again, in those instances where water-butts have been provided for cottages the capacity of these butts seemed to me insufficient for their purpose.

In the court in which Queen's Terrace stands, Queen Street, but one water tap is furnished for 15 houses. Again, at the back of Mount Pleasant I observed one water-butt for 15 cottages, and in Crooked Lane I observed a small water-butt assigned to five cottages.

The water supplied by the Company, as it comes from the pump-well, as shown by an analysis made during the inquiry (*see Appendix*), is of exceptional purity. Dr. Dupré says of it that "though somewhat hard, it is, on account of its remarkable freedom from contamination, an admirable water."

The foregoing details as to the drainage, disposal of excremental filth, and water-supply from private wells in Gravesend, will show that the local conditions for the development of enteric fever and cognate disorders exist there abundantly, and supply a sufficient explanation of the habitual prevalence of the fever in the borough. Excremental pollution of the soil and of the air is general, although more obvious in some localities than in others; and near upon a fifth of the population† drink a water which is in every case liable to be, and in many instances obviously must be, polluted with excrement.

Now it is a singularly pregnant fact *that the progressive decrease in the general mortality of Gravesend, and especially the remarkable decrease in its mortality from "fever" and from diarrhæal disease, has gone on concurrently with a progressive increase in the distribution and use of the purer water supplied by the Water Company.‡* I have no

* Mr. Whitaker (*Memoirs of the Geological Survey of England*, Vol. IV., pt. 1., p. 464) quotes the following section of the first well sunk by the Water Company (since deepened) from the Revd. J. C. Clutterbuck's work on the "Supply of Water to the Metropolis from the Valley of the Colne" (Watford, 1842).

				Feet.
Loam and gravel	[? Woolwich beds]	-	-	20
Sand	[Thanet]	-	-	46
				—
		To chalk	-	66
Chalk and flints	-	-	-	68
				—
				134
				—

† Assuming that the average number of inhabitants per house to be the same as existed at the Census of 1871, namely, six, the number of the population supplied by the Water Company in 1876 (3,065 × 6) would be 18,390. Estimated population 1876, 22,618 — 18,390 = 4,228 deriving their supply from private wells in that year.

‡ GRAVESEND :—Water Supply.

—				Inhabited Houses.	Houses supplied with Water by the Water Company.
1851	-	-	-	2,722 enumerated	1,358
1861	-	-	-	3,062 „	1,921
1871	-	-	-	3,485 „	2,776
1876	-	-	-	3,827 estimated	3,065

doubt whatever, in my own mind, that the principal source of this decreased mortality, has been this substitution of pure for impure water for domestic use; and no part of the local authority's administrative sanitary work at the present time is productive of such immediate benefit to the health of the borough as the steady process of closing wells and compelling the use of the Company's water which it is now engaged in. The greater attention given by the Local Authority of late years, especially since the appointment of a Medical Officer of Health, to the detailed sanitary requirements of the borough, especially as shown in the removal of obvious nuisances, the regulation of slaughter-houses, &c., has no doubt contributed to general improvement in the sanitary condition of the place, but the influence of these measures cannot well be estimated while any portion of the water supply in domestic use remains polluted with excrement, and while the present system of excrement disposal exists.

The closure of all private wells and the extension of the Company's water supply to the whole population would, I have no doubt, be followed by a further marked improvement of the health of Gravesend. But this being done, and as quickly as may be practicable, the unwholesomeness of the cesspools remains to be dealt with. This is only possible effectually by the substitution of a less barbarous system of excrement disposal; and until such a complete change has been executed Gravesend will fail of the healthiness of which it is capable.

Of the particular complaints included in this inquiry but a brief notice is required.

(a.) I am satisfied that there has been sufficient reason for the reiterated complaints addressed to the Board of nuisance caused at the canal basin east of the town by the deposit there and carting away of highly offensive stuff, including decaying fish, used as manure. Excepting the fish, this stuff appears to be brought from London in barges, and to consist of all the varied refuse of the metropolis, other than human excrement, as for example, market refuse, brewers' refuse, stable manure, &c., whatever in fact admits of use for agricultural purposes. This in various stages of decomposition, and with a wide range of offensiveness, together with cargoes of small fish caught solely for manure and having a vast capacity of stench, is deposited on the edge of the canal basin for the convenience of carting into the country. It is plain that what is wanted to prevent this nuisance is the speedy removal of all these manurial substances to their proper destination; but if any accumulation takes place, there should be no difficulty in abating this nuisance either by covering the deposit with a layer of dry earth or of charcoal. The byelaws of the Corporation* require that the carriage of such matters in the borough shall be effected in covered vessels or carts so constructed that their contents cannot escape. This byelaw does not appear to have been as yet put in force.

(b.) I am satisfied also that good ground exists for the complaint of great nuisance caused by the discharge of sewage on the bed of the river above low-water mark, at the foot of the town pier. The Local Authority has sought to abate this nuisance since the commencement of the present inquiry, and has proposed a plan for carrying the outlet of the sewer below low-water mark, but this plan has not been approved by the Thames Conservators. The outlet at the foot of the town pier, and other drain outlets on the river face of the town, are all objectionable, and are, I should infer, the principal source of the foulness of the mud which lies along the river face. The drains opening upon the river face should in fact, if practicable, be carried into an intercepting sewer running along West Street, as part of a system of sewerage for the town, with an outlet lower down the river, and arrangements for clarifying the sewage before it is passed into the stream.

(c.) The complaint of nuisance from an accumulation of vegetable matter, manure, and rubbish on Windmill Hill was one of a series of complaints including questions of encroachment and unsafe pathways having no sanitary bearing, and not coming, therefore, within the scope of this inquiry. At the time of my inspection there was no obvious nuisance from the accumulation complained of, a collection of garden refuse upon private premises. The complaint had previously been brought to the notice of the Medical Officer of Health and of the Inspector of Nuisances, both of whom were with me at the time of the inspection.

* Approved by the Local Government Board, September 1876.

Recapitulation.—The facts elicited during the inquiry may be briefly recapitulated as follows :—

1. Gravesend has lately suffered, and is still suffering to some extent, from a widely diffused and fatal outbreak of scarlet fever.

2. At the time of the commencement of this outbreak there was a considerable development in the borough of enteric fever.

3. The Local Authority possesses no means for isolating cases of infectious disease, nor has it any sufficient provision for disinfecting by heat or otherwise infected articles of bedding or clothing.

4. Enteric fever is endemic in the Borough, and its local persistence and prevalence concurs, as customary, with excremental pollution of the soil, of the air, and partially also of the water.

5. This sort of pollution depends upon the storage, for periods varying from two to thirty years or more, of excremental filth in cesspools, hollowed out in the porous rock upon which the houses stand and in their immediate vicinity, each house or each group of houses having its particular cesspool or cluster of cesspools.

6. At one time the whole of the water supply of the town was obtained from wells dug contiguous to, and into the same stratum of rock, as the cesspools. One fifth of the population is now alone supplied with water from wells so situated.

7. Concurrently with the extension of a purer water supply among the inhabitants, there has been a diminution of the general mortality of the borough, and especially a marked diminution of the mortality from fever and from "diarrhœal disease."

8. The particular nuisances complained of (*a*) from the deposit at and cartage away from the canal basin of offensive stuff and decaying fish, used as manure, (*b*) and from the flow of sewage over the bank of the river at the foot of the town pier at low water, exist.

Local Government Board,
16th July 1877.

J. NETTEN RADCLIFFE.

Recommendations.—1. A hospital for infectious diseases should be provided.

2. An apparatus for the disinfection by heat of clothing, bedding, and textile fabrics liable to retain infection, should also be provided with necessary appurtenances.

3. It is desirable that all private wells used for domestic purposes should as far as practicable be closed, and the Local Authority should use to the fullest extent its statutory powers for closing such wells as can be ascertained to be polluted. The use of the Water Company's water should be promoted as much as possible throughout the whole borough.

4. The town should be systematically sewered, and where sewers have been provided the Local Authority should require every house to be connected with them. It should obtain by all means in its power the disuse of all cesspools, exercising fully its statutory powers for abolishing with all proper precautions such cesspools as are a nuisance. In general a water-closet system in connexion with the public sewers will be the right system of excrement disposal. But in the event of any doubt arising as to the sufficiency of the water supply, present and prospective, to admit of an universal water-closet system, then a plan of frequent removal of the excremental filth may be adopted, founded upon the system of scavenging of dry refuse now in use in the borough, and following as model either the Manchester or the Rochdale or other pail-system of excrement disposal, in which the interval of removal does not exceed one week.

5. The nuisance at the canal basin should be abated by speedy removal of the offensive matters deposited there, no accumulation being permitted beyond what can efficiently be dealt with by the use of deodorants such as dry earth or charcoal; and with respect to the cartage of such matter the Local Authority's byelaw on the subject should be enforced.

6. The proper means of abating the nuisance from sewage flowing over the river bank at the foot of the town pier at low water, as well as nuisance from sewage flowing from other drain outlets at other points of the river face of the town, is by carrying out a system of sewerage as recommended above. (§ 4.)

APPENDIX.

REPORT on two SAMPLES of WATER received from Dr. J. H. GRAMSHAW, March 19, 1877, sent by direction of Mr. NETTEN RADCLIFFE.

No. 1, contained in two Winchester quarts, stoppers tied over and sealed, seals unbroken, each bottle labelled, "Water from Gravesend Waterworks taken by myself from the large outfall into the reservoir, March 17, 1877. "Flow has been going on for a considerable time, 12 a.m. J. H. GRAMSHAW."

The water is clear, almost colourless, and remarkably free from recent contamination of any kind, as shown by the total absence of ammonia, the extremely small proportion of albuminoid ammonia yielded, and the non-absorption of oxygen from permanganate. The water, though somewhat hard, is, on account of its remarkable freedom from contamination, an admirable drinking water.

No. 2, contained in two Winchester quarts, stoppers tied over and sealed, seals unbroken, each bottle labelled, "Water taken by myself from the stand pipe in Passengers Court, Gravesend, March 17, 1877, 2½ p.m. "Supply here intermittent, had been going on for some time. J. H. GRAMSHAW."

The water is not perfectly clear, of greenish yellow colour, and on standing yields a minute trace of deposit, consisting of various fungoid growths. On the whole it is also a very pure water, but is slightly less pure than No. 1, as shown chiefly by the larger amount of albuminoid ammonia yielded and by its action on permanganate. The residue left on evaporation is also slightly yellow, while that left by No. 1 is perfectly white. The water, in its passage from the outfall into the reservoir to the stand pipe has evidently suffered a slight deterioration.

The analytical details are given in the table annexed—

	No. I.	No. II.
Appearance - - - -	Clear - -	Very slightly turbid.
Colour - - - -	Pale greenish	Greenish yellow.
Taste - - - -	Tasteless -	Tasteless.
Smell - - - -	Inodorous	Inodorous.
Deposit - - - -	None - -	Minute trace.
Nitrous acid - - -	None - -	None.
Phosphoric acid - -	Minute trace -	Minute trace.
Hardness before boiling	19 degrees -	18·6 degrees.
" after "	2·8 " -	2·8 "
Grains per gallon.		
Oxygen absorbed from permanganate -	0·000	0·003
Total dry residue - - -	26·11	25·90
Consisting of—		
Volatile matters - - -	2·24	3·08
Fixed salts - - - -	23·37	22·82
Chlorine - - - -	1·57	1·57
Nitric acid - - - -	1·70	1·74
Ammonia - - - -	0·000	0·000
Albuminoid ammonia - -	0·002	0·003

Westminster Hospital,
March 22nd, 1877.

(Signed) A. DUFRÉ.